

Rapid detection of trace quantities of explosives

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Rapid screening for trace levels of explosives is necessary for security purposes within the aviation industry. Typically, this is carried out using ion-mobility spectrometry, however these instruments are often low resolution which can give out false positive results. Using mass spectrometry can provide specificity through the generation of multiple characteristic ions whilst also providing acceptable levels of sensitivity. When coupled with an ambient ionisation technique results can also be produced rapidly with minimal sample preparation required. Here we investigate the sensitivity for 5 different explosives: HMTD, TNT, RDX, tetryl and PETN using two ambient ionisation techniques, atmospheric solids analysis probe (ASAP) and thermal desorption corona discharge (TDCD).

Certified reference standards were diluted in methanol to produce calibration curves ($n=5$) and a set of infinite dilutions to determine the limit of detection. Thermal desorption experiments were carried out on the Waters Acquity QDa mass spectrometer with fibre glass swabs for sample introduction and ASAP experiments were carried out on the Waters RADIANT mass spectrometer using glass rods for sample introduction.

The ion species produced from each explosive have been identified and the ion chemistries elucidated. The linearity and repeatability were in line with what would be expected for an ambient ionisation method for all the explosives analysed. The limits of detection show nanogram sensitivity on both ambient techniques, with picogram sensitivity observed for RDX, TNT and tetryl using ASAP.

Both ambient ionisation techniques provide limits of detection that may be suitable for the trace detection of explosives within a security setting. Whilst ASAP appears to be more sensitive as a result of lower background signals (due to the glass rod sample introduction), the fibre glass swabs used with thermal desorption provide a better sampling device in a real-world setting (effectively providing sample pre-concentration by sampling from a wide area).